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Determination of Diversity Indices of Araneid Fauna Captured from Guava Orchards by Pitfall Trapping Method at Gujranwala, Pakistan

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Abstract: Araneid fauna captured by pitfall trapping method belonged to seven families, ten genera and twenty two species. Family Lycosidae (62.35%) comprised of genus *Lycosa*, *Pardosa* and *Hippasa* while Saltisidae (22.47%) consisted of *Marpissa* and *Plexipus*. Thomididae (9.5%) contained *Thomisus bulani, T. elongates, T. pugilis* whereas families of Araneidae (1.68%), Clubionidae (1.68%), Gnaphosidae (1.12%) and Oxiopidae (1.12%) contributed the least fauna to the current studies. The maximum Araneid fauna was favored by the maximum temperature 42.8 °C, relative humidity 61.4% and average rain fall of 40 mm in the month of June while least were trapped at temperature 30.2°C, relative humidity (R.H.) 62.4% and 25 mm rainfall in the month of October. Species richness, Shannon diversity index, Pielou's evenness index and Simpson diversity index were 57.58, 2.83, 0.91 and 0.93, respectively.

Key words: Spiders · Population · Temperature · Diversity · Abundance · Species

INTRODUCTION

The climate of Punjab is very diverse and suitable for the wide varieties of crops. But unfortunately phytophagous insects cause serious damage to agricultural crops, vegetables and fruit trees, ornamental and wild plants. In the recent year, the use of the insecticides in the agro-ecosystems of Pakistan has increased by several folds. Unintelligent use of insecticides adversely affected the non-targeted organism, that not only causing harms to human health but also deplete biodiversity essential for ecological stability. Majority of insecticides used for inhibiting the pest population are toxic to man and other animals [1]. In the absence of other alternate effective means, farmers are relaying on more and more insecticides for ridding their crops of insect pests. Consequently, agro-ecosystem is being loaded with toxicants through the use of these chemicals, whose adverse impact on human health and agro-ecosystem is not fully known. In agro-ecosystems of Pakistan, intercropping is commonly practiced; biologically diversity is much greater than general witnessed in monocultures [2, 3]. Naturally in such biologically rich systems, as are the agro-ecosystems of central Punjab (Pakistan) and indiscriminate use of toxicants may unnecessarily destroyed many of the non-target species possibly favoring the pests by eliminating their natural enemies and competitors through the use of chemicals. Once the natural constraints against pests' species are weakened, a sustained use of insecticides becomes essential otherwise the pest populations would buildup and the crops would suffer losses on larger scales [4].

Sankari and Thiyagesan [5] studied population of spiders and their predatory potency on *Solanum melongena* (Brinjal) and *Trichisanthes anguina* (snake-gourd) fields in two different areas viz. Nangoor (pesticide free area) and Moongilthottam (frequently pesticide used area) of Nagapattinam District, Tamilnadu. The population of spiders did not show significant difference between areas, plants and number of species of spiders. This present study aims to contribute to our growing knowledge on the distribution and ecology of spider communities across the Gujranwala and will provide a true foundation for further studies regarding araneid fauna.

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MATERIALS AND METHODS

Gujranwala is located at 32.16° North, 74.18° East and is 226 meters (744 ft) above sea-level. The driest months are usually November through April where little rainfall is seen. The coldest months are usually October to February. The temperature can drop to an average 7°C. Whereas the other months average rainfall is roughly 25 mm. The climate of Gujranwala ranges quite drastically throughout the year. The summer periods last from June through September where the temperature reaches 36-42 °C. The density of spiders in guava orchards was investigated using 2 types of sampling methods (pitfall traps and hand picking) every week from March to October, 2011. To collect ground spiders, 20 pitfall traps consisting of wide-mouth glass jars (6 cm in diameter × 12 cm deep) were installed diagonally. Four pitfall traps (5 × 5 m grid pattern) were installed at each corner of the plots and 4 in the center. These traps were buried into ground with the mouth of jars leveled to the ground surface for seven days. Ethylene glycol (95%; 250 ml) and 2 drops of 1% liquid detergent were added to each trap to break the surface tension. A rain cover (18 × 18 cm) constructed of 0.6 cm plywood and supported by 3 nails (9 cm long) was placed over each trap (the height of rain cover over the mouth of the glass jar was 30 cm). Foliage organisms (spiders and other invertebrates) were collected through hand picking from Mar to Oct. All traps were emptied after seven days. Spiders from each trap were collected and brought to the laboratory. Captured spiders were washed in xylene, placed in small jars with 70% ethanol and transported to the Arachnology laboratory Government College University, Faisalabad for sorting and identification. Finally spiders were preserved in vials, containing a solution of 70% ethanol and glycerin and prepared for ecological studies. Data obtained was analyzed for the species relative abundance and other diversity indices. The number of species per sample is a measure of richness. Evenness is a measure of the relative abundance of the different species making up the richness of an area. Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. Spiders were identified using relevant material provided by Dyal [6] and Tikader and Malhotra [7].

RESULTS AND DISCUSSION

A total of 222 specimens belonged to seven families, 10 genera and 22 species were recorded. Of the total species most dominant *Pardosa birmanica*, *Lycosa madani* and *Lycosa kempi* while the remaining was less frequent. Family Salticidae comprised of genus *Marpissa* and *Plexipus* with less and more and specimens respectively. Family Thomicidae represented by genus i.e. *Thomisus bulani*, *Thomisus elongates*, *Thomisus pugilis*. Family araneidae (1.68%) consisted upon one species *Neoscona bengalensis*. Family Clubionidae contained fewer specimens of the same species i.e. *Clubiona sp.* Family Gnaphosidae represented two specimens of two species i.e. *Gnaphosa harpax* and *Gnaphosa eucalyptus*. Fewer specimens belonged to family Oxyopidae with single species i.e. *Oxyopes ratnae*. Tahir *et al.* [3] recorded 1098 araneid fauna including 38 species, 22 genera and 9 families. Lycosidae was that most abundant family whereas Gnaphosidae contained the highest spider fauna. Ghafoor and Mahmood [1] gathered one hundred and seventy eight specimens belonged to seven families, 10 genera and 22 species captured from guava fields located at Gujranwala, Pakistan. Matrix plots are showing the diversity of spiders with the environmental factors as given in Table 2.

Family Lycosidae remained its peak position with 3 genera i.e. *Lycosa*, *Pardosa* and *Hippasa* represented by 53 species and 23 specimens. *Pardosa birmanica* was the most abundant species while *Lycosa madani* and *Pardosa oakleyi* (9.5%) were moderately dominant over the remaining species. Not even a single spider of Family Clubionidae and Family Gnaphosidae was recorded from site under study. Indices of diversity i.e. richness (R), Pielou's evenness (E), Shannon index (H) and Simpson's (D) were calculated 57.58, 0.91, 2.83 and 0.93, respectively. Tahir *et al.* [3] demonstrated that araneid population showed consistent increasing trends among the populations of immature and adults from January to August. Further found five most abundant species of Lycosidae family comprised of 67.77% of the total captured fauna. The maximum spiders were collected during the month of June, when average rainfall (mm), maximum temperature (°C) and relative humidity (%) recorded were 40, 42.8 and 61.4, respectively. Maximum araneid specimens were recorded when average temperature, relative humidity and rain falls were 35.1°C, 61.4% and 40 mm. Least number of spiders i.e. (6) was trapped when the average temperature (°C), relative humidity (%) and rain fall (mm) were 24.85° C, 62.4 and 25 mm. The months of April (34) and May (35) represented same number of araneid specimens. Tahir *et al*. [3] represented that adult spiders increased from month of January to April. Its population decreased in the months after April than again found increased in the month of June as represented in Table 1.

Table 1: Data for the captured species from the study area with their families (%) representing their contribution to the whole captured population

Species	No.of specimens	Family	%
Neoscona bengalensis	4	Araneidae	1.68
Clubiona sp.	4	Clubionidae	1.68
Gnaphosa harpax	2	Gnaphosidae	1.12
Gnaphosa eucalyptus	2		
Lycosa madani	23	Lycosidae	62.35
Lycosa kempi	15		
Lycosa tista	6		
Lycosa mackenziei	9		
Pardosa birmanica	25		
Pardosa oakleyi	19		
Pardosa leucopalpis	9		
Hippasa holmerae	15		
Hippasa madraspatna	8		
Oxyopes ratnae	4	Oxiopidae	1.12
Marpissa carinata	10	Saltisidae	22.47
Marpissa tenebrosa	8		
Marpissa mirabilis	6		
Plexipus bengalensis	15		
Plexipus pakulli	11		
Thomisus bulani	9	Thomisidae	9.5
Thomisus elongatus	7		
Thomissus pugilis	7		
Total	222		100

Table 2: Correlation Coefficients (r) among the families of Araneid fauna with temperature (°C), relative humidities (%) and rainfall (mm) collected from the guava orchards at Gujranwala.

Parameters	Families	Temperature (°C)	Relative humidity (%)	Rainfall (mm)
Families	1	-	-	-
Temperature (°C)	0.929**	1	-	-
Relative humidity (%)	0.230^{NS}	0.977**	1	-
Rainfall (mm)	0.431^{NS}	0.539^{NS}	0.331^{NS}	1

Table 3: Diversity Indices of araneid fauna trapped by pitfall method from guava orchards at Gujranwala.

Component	Values
No. of Species	22.00
Species Richness (R)	57.58
Shannon Diversity Index (H)	02.83
Pielou's Evenness Index (E)	00.91
Simpson Diversity Index (D)	00.93

The aim of the study was to identify the spider families present at current research Guava Orchards area at Gujranwala, determine to what degree family densities and composition varied within habitat and how varying ecological factors affect spider population through different months. Comparisons were made between communities of paired sites. The results from data demonstrated a slight degree of variability. A general look on the result showed that the family Lycosidae was the most abundant among the all seven families during the whole trapping session. The order of abundance of the families was Lycosidae > Saltcidae > Thomicidae, Araneidae, Gnaphosidae, Clubionidae and Oxyopidae. Month of June with its climatic conditions i.e. average rainfall, temperature and relative humidity found to be more suitable for spider population to increase because highest proportion of spiders i.e. 21.12% was trapped during this same month as correlation coefficients are showed in Table 2. Results clearly demonstrated that increase in temperature and relative humidity favoured spider population to increase through March to June. But on the other hand increase in rainfall suppressed spider population in the months of July and August while temperature and relative humidity were quite high. July was recorded the month of highest temperature and average rainfall but with decline in the number of spiders. Ecological factors favored the boosting of araneid fauna till June with high temperature and relative humidity then slowly decreased through July to October because of decrease in temperature and increased rainfall. Ghafoor and Mahmood [1] demonstrated that temperature and humidity favored the spider population from month of

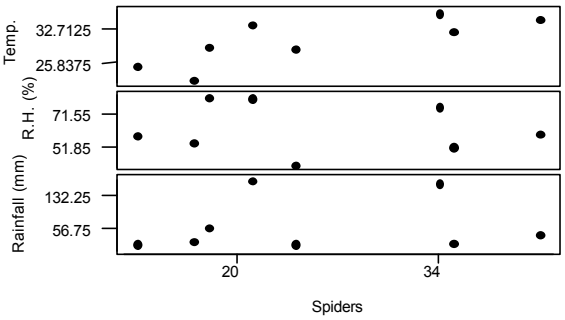

Fig. 1: Relationship among spider fauna with temperature, relative humidity and rain fall captured from the citrus orchards.

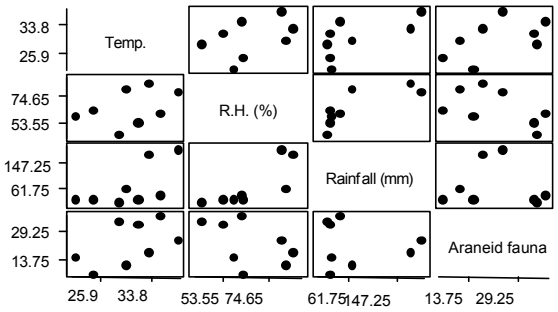

Fig. 2: Matrix plot representing spider fauna with the change in temperature (°C), rainfall (mm) and relative humidity (%).

March (15) to June (37). They also observed that temperature and rainfall found high in the month of July but both parameters did not favored its population as given in Table 3.

The Ferguson [8] reported the same order of dominance for Lycosidae and Linyphiidae family. He also reported that population of ground dwelling spiders peaked in the June and were dominated by Lycosidae. Family Lycosidae not only showed the overall dominance but also present in huge percentage in each month during pitfall trapping sessions. It was 57.28% in April, 65.6% in May and 59.18% in June and with little bit difference in percentage in remaining months. Family Lycosidae was 65.7%. The similar studies but in different habitats in temperate zone Duffy, [9] showed that the Lycosids accounted for 43% of the cursorial species and 55 percent of the cursorial spiders. It may be possible that this phenomenon acted during the study and specimens of *Lycosa* derived out genera and become dominant or may effect seasonal changes. Ghafoor [10] gathered 74% of Gnaphosidae from the cotton fields whereas Maqsood [2] collected 62% and 55% from the fruit and guava gardens respectively. In other studies Alvi [4] captured maximum number of spiders from March to July. The diversity indices are given in Table 3.

The possible inclusion of additional diversity measures in subsequent studies may yield more fitting or consistent results, as no single index can perfectly reflect the diversity of a given species [11]. The high rainfall during the trapping session did not affect spider's abundance significantly due to high temperature and relative humidity suitable for their reproduction. As the study was carried out in the hotter months of the year; the abundance, species richness and diversity was significantly high during the study period. During these months due to high temperature, relative humidity, ample light and abundant food made the period favourable for the spider population. Recent studies have also discussed the possibility that applying diversity indices to invertebrate studies may posses intrinsic shortcomings, since the rate of capture is linked with individual activity and detectability [12]. Abundance of Lycosids and remaining families clearly demonstrate this point: both species abundances and diversity varied with time of collection. In future studies, a collection schedule that included a range of day and night-time as well seasons and even micro-habitats, would contribute to a more accurate picture of spider community structure. Similar studies were also carried out by Tahir *et al*. [3] by analyzing the activity density of spiders captured from the citrus fields. He found three dominant families i e. Lycosidae 68.85%, Gnaphosidae 10.38 and Saltisidae 8.38%. From the current studies it was concluded that the environmental factors like temperature, humidity and rainfall etc. effect the araneid populations in various agricultural fields. Further studies on their diversity indices (Shannon diversity index, Pielou's evenness index and Simpson diversity index) may be helpful in exploring the importance of araneid fauna inhabiting the different crop, fruits and vegetable fields for the biological control of insect pests.

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